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PSYCHOLOGICAL CHARACTERISTICS UNDERLYING THE EDUCABILITY OF THE MENTALLY RETARDED CHILD. I. CONCEPT FORMATION AND TRANSPOSITION IN YOUNG MENTALLY RETARDED AND NORMAL CHILDREN.

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REPORTED HERE IS A COMPARATIVE-DEVELOPMENTAL ANALYSIS OF TRANSPOSITION AND LEARNING IN YOUNG MENTALLY NORMAL AND MENTALLY SUBNORMAL CHILDREN. THE STUDY ATTEMPTED TO DETERMINE THE EXTENT AND NATURE OF THE LEARNING DEFICIT OF THE MENTALLY RETARDED CHILD. TWO LEARNING TASKS WERE DEVISED TO PERMIT SAMPLING PERFORMANCE ON SUCCESSIVE SERIES OF DISCRIMINATION TASKS. TRANSFER OF LEARNING BETWEEN THE TWO TASKS WAS ASSESSED FOR THE MENTALLY NORMAL AND MENTALLY SUBNORMAL SUBJECTS. RESULTS WERE THEN CORRELATED WITH CHRONOLOGICAL AGE, NATURE OF THE STIMULUS, CUE, SEX, AND MENTAL GROUPINGS (NORMAL, FAMILIAL, AND MONGOLOID). ON THE FIRST TASK, AN ODDITY LEARNING TASK, A SIGNIFICANT DIFFERENCE WAS OBSERVED AMONG TOTAL TRANSPOSITION SCORES OF THE THREE GROUPS. THE DIFFERENCE DISAPPEARED AFTER ADJUSTMENT OF MEAN DIFFERENCE IN MENTAL AGE. SCORES OF BOYS IN THE NORMAL AND FAMILIAL GROUPS WERE SUPERIOR TO SCORES OF GIRLS. THE REVERSE WAS OBSERVED IN THE MONGOLOID GROUP. THERE WAS NO DIFFERENCE BETWEEN NORMAL AND FAMILIAL GROUPS IN INCIDENCE OF TRANSPOSITION ON THE SECOND LEARNING TASK. IT WAS CONCLUDED THAT DEFICITS OF FAMILIAL SUBNORMAL CHILDREN CAN PROBABLY ACCOUNT FOR THEIR MENTAL AGE. MONGOLOID CHILDREN EXPERIENCE DISCRIMINATION AND GENERALIZATION DEFICITS THAT CANNOT BE ATTRIBUTED TO MENTAL AGE. THE RESULTS SUPPORT THE BELIEF THAT LEARNING DEFICIT IS CRITICALLY RELATED TO THE ABILITY TO DIRECT AND MAINTAIN ATTENTION. (WN)

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PSYCHOLOGICAL CHARACTERISTICS UNDERLYING THE EDUCABILITY OF THE MENTALLY RETARDED CHILD: I. CONCEPT FORMATION AND TRANSPOSITION IN YOUNG MENTALLY RETARDED AND NORMAL CHILDREN[1]

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Two conceptualizations in modern learning theory concern discrimination and generalization or the application of old learning to new problems. The first, transposition (Köhler, 1925), explains discrimination and generalization in terms of relational, rather than stimulus, similarities: A subject can be taught to choose the smaller of two objects A and B. If he is then confronted with objects B and C--with B, formerly the incorrect stimulus, now the smaller and thus the correct stimulus--he will succeed in the second task to the extent that he recognizes the "smaller than" relation that is common to both situations. Insofar as he does choose the smaller object in the second task, he is said to transpose.

While not rejecting a theory of discrimination and learning based on relative characteristics, Harlow (1949) emphasizes the importance of formation of learning sets, or learning to learn. As a consequence of experience with hundreds of specific discrimination problems, his subjects seem to acquire "a generalized ability to learn any discrimination problem" (p. 59).

[1]The research reported herein was performed pursuant to a contract (No. SAE-7150) with the United States Office of Education, Department of Health, Education, and Welfare.

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Both conceptualizations have generated much research, a large part of which utilizes infrahuman subjects and attends to the theoretical issues involved. Particularly is this true with regard to transposition because of an alternative explanation of discrimination and generalization based on absolute rather than relative properties of stimuli offered by Spence (1937, 1942, 1952).

There have also been a number of investigations of discrimination learning and transposition in children, not without their theoretical implications, but reflecting also the practical importance of determining the ability of children to discriminate and generalize, particularly as this ability is related to such variables as chronologic age, mental age, sex, stimulus characteristics, quality and quantity of training on the original task, and nature of discrimination and generalization required. The results of these studies may be summarized briefly as follows:

1. Incidence of transposition increases with chronologic age to 10-12 years (Alberts and Ehrenfreund, 1951; Kuenne, 1946; Stevenson, Iscoe, and McConnell, 1955).
2. Transposition behavior is positively related to mental age (Kuenne, 1946; Spiker and Terrell, 1955; Stevenson and Iscoe, 1955), as is the formation of learning sets (Koch and Meyer, 1959).
3. No significant sex differences in transposition have been reported.
4. Young children learn to discriminate among stereometric objects (cubes) more rapidly than they do among planometric objects (thin squares) or patterns (squares painted on cardboard); they find discrimination more difficult when the correct stimulus is the middle-sized of three objects than when it is either the smallest or the largest (Stevenson and McBee, 1958). Young children

transpose most frequently with abstract, next most frequently with concrete, and least frequently with representational stimuli, regardless of the nature of the training stimuli (Oderkirk, 1959).

5. Pretraining on distinctive stimuli or on several stimuli facilitates performance on a discrimination task (Spiker, 1956b, 1956d, 1959; White and Spiker, 1960).
6. The degree of transposition and generalization is positively related to amount of training (Spiker, 1956a; Stevenson and Iscoe, 1954).
7. The ability to verbalize is positively related to incidence of transposition (Alberts and Ehrenfreund, 1951; Kuenne, 1946).
8. Providing children with verbal labels for stimulus objects and for concepts, whether nonsense or meaningful, facilitates discrimination and generalization (see Spiker, 1956c, for review of a number of studies).
9. Both reward for correct responses and punishment for incorrect responses enhance discrimination learning (Stevenson, Weir, and Zigler, 1959); as does high frequency of reinforcement in pre-training (Steigman and Stevenson, 1960; Stevenson and Pirojnikoff, 1958).
10. As the distance (or difference) between the training and test tasks increases, incidence of transposition decreases, particularly in younger subjects (Alberts and Ehrenfreund, 1951; Kuenne, 1946; Stevenson and Bitterman, 1955). As the time lapse between training and test increases, incidence of transposition increases (Stevenson and Langford, 1957).

It is important to note that, with the exception of Stevenson and Iscoe (1955), all the studies cited in this summary utilized normal children as subjects and most of them the stimulus property of size (middle, larger than, or smaller than) to be discriminated and generalized.

Prior to the time that the present investigation was designed and the data for it collected, only one study of transposition in mentally subnormal subjects (children and adults) (Stevenson and Iscoe, 1955) and no comparative studies of normal and subnormal children had been reported.[3] In view of this lack of information and in view of the critical importance of concept formation and transposition for the education of mentally subnormal children, it seemed desirable to assess the learning deficit, if any, of such handicapped children. A comparative-developmental investigation of these abilities in young mentally normal and mentally subnormal subjects was designed to answer the following questions:

1. With what success can concept formation and transposition be measured in mentally subnormal children?
2. What changes, if any, in concept formation and transposition occur with advance in chronologic and mental age in mentally subnormal children?
3. What quantitative and qualitative differences may be observed in the development of these abilities between mentally subnormal and normal children?
4. How are these abilities related to etiology of mental subnormality (endogenous or exogenous)?

[3]Subsequent to the completion of this study, a number of reports of research on learning and transposition in mentally normal and subnormal children appeared. Kaufman and Peterson (1958) were thus able to state: "To the authors' knowledge the present paper represents the first attempt to use the learning-set technique to compare normal and mentally retarded children" (p. 621). Appropriate reference to this and other studies will be made in the discussion of the findings of the present investigation.

Subjects[4]

It was intended that the sample for this investigation should include approximately 64 mentally normal children and 64 mentally subnormal children in the chronologic age range, 48 to 96 months; the former with an IQ of 90 or above, the latter in the IQ range from 50 through 79. For reasons to be described below, circumstances made it impossible to realize this intention, except with regard to numbers of subjects in each group where the goal was exceeded. Furthermore, sampling, in any rigorous sense of that term, was impossible. The reference throughout the report will therefore be to subjects, not to samples.

Mentally Subnormal Children

Two major sources of mentally subnormal children were available in the State of Indiana; (a) two state institutions, Fort Wayne and Muscatatuck; (b) public or private community classes for retarded children. A letter was sent to the person-in-charge of each of some 24 community classes, describing the proposed study and asking for their cooperation, first, by supplying information on number, CAs, IQs, and etiological classification of the children enrolled. Replies were received from 16 classes, expressing willingness to participate in the study and providing the information requested insofar as it was available. Upon examining these replies, it became clear that

[4]The investigators are indebted to the administrative officers and the staffs of the following Indiana schools and institutions for their generous assistance in providing subjects and facilities for this study: Associated Parents Nursery School, West Lafayette; Burtsfield Elementary School, West Lafayette; Day Nursery Center of Indianapolis; Fort Wayne State School; Morton Elementary School, West Lafayette; Muscatatuck State School; Purdue University Nursery School, Lafayette; and South Side Community Center, Lafayette. Of the many individuals who contributed their services and encouragement, special mention should be made of Bernard Dolnick, Superintendent, Fort Wayne State School; William Floyd, Superintendent, West Lafayette Public Schools; Iona C. Hamlett, Director of Psychological Services, Fort Wayne State School; and Donald H. Jolly, Superintendent, Muscatatuck State School.

(a) there were very few children enrolled in any one community class, particularly at the younger age levels and (b) little, if any, reliable information on the intelligence and etiology of even these few subjects was available. It was therefore necessary to look to the state schools as the source of mentally subnormal children.

The members of the project staff examined in detail the case folders on all children in both institutions who might possibly be acceptable as subjects. Again, it was surprising to find how relatively few young children had been admitted, presumably reflecting a tendency on the part of parents to delay commitment as long as possible. Moreover, it was found that etiological classification, in many cases, was ambiguous, mixed, tentative, or undertermined. In view of these facts, it was necessary to revise the original specifications for the mentally subnormal subjects as follows: (a) the upper limit of the chronologic age range was extended to 204 months; (b) only children with an unequivocal diagnosis by the professional staff of the institution as either mongoloid or familial with no gross motor or sensory impairment were considered; (c) no lower limit on range in IQ was set. There were obtained from the two state institutions a total of 66 subjects who met these specifications and for whom complete and accurate test records were secured: 44 familials, 24 boys and 20 girls; 22 mongoloids, 12 boys and 10 girls.[5] For the total number of children, the CA range was 95 to 205 months; the IQ range was from 11 to 71. A more detailed description of these two groups of mentally subnormal children will be found in the presentation of the results of the comparative analysis.

[5]One mongoloid girl was actually 205 months of age at time of testing.

Mentally Normal Subjects

It seemed advisable to select a group of mentally normal subjects of approximately the same chronologic age range (in amount) as the mentally subnormal children. In addition, an attempt was made to obtain subjects of both middle-class and working-class background, defined in terms of parental occupation and education. For, in examining the case records for the mentally subnormal subjects, it appeared that the socioeconomic status of the familial children could be characterized, almost without exception, as depressed or deprived; that of the mongoloid subjects, in contrast, was quite heterogeneous. That is to say, incidence of mongolism was independent of social class status; incidence of the familial type of mental retardation was correlated with such status.

The following sources of normal subjects were utilized: two nursery schools and two elementary schools in a university community; two community centers, one city, one town. The mentally normal group included a total of 174 children, 96 boys and 78 girls, with a CA range of 30 to 134 months and an IQ range of 88 to 140, the latter applying only to that portion of the group for which reliable intelligence test data were available. Of these, 143 children, 80 boys and 63 girls, were classified as middle class; 31, 16 boys and 15 girls, as working class. Several subgroups were drawn from this total number; they will be described in greater detail in the presentation of the findings.

Procedure

An earlier intention of using a task based upon the concept of middle size was abandoned when exploratory testing indicated that it lacked sensitivity in differentiating among children varying rather widely in chron-

ologic age and intelligence. Instead, a task based on the concept of oddity, following the earlier work of Miller (1934), was devised and proved to be much more satisfactory for the purposes of this investigation. This task was administered to all mentally normal and subnormal subjects. Later, a modified version of the learning-of-middle-size task was administered to the familial subjects in one institution and a subgroup of normal subjects. These two tasks will now be described:

Oddity Learning Task (OLT)

The task was choosing the odd one of three stimulus objects with oddity defined in terms of either size, color, form, or spatial orientation. There were two training series, each run with correction to criterion of four consecutive correct responses:

1. three squares, odd one small (488)[6]
2. three squares, odd one large (448)

There were then eight tests, each with six noncorrected trials, introduced without comment to all subjects in the following sequence:

1. three triangles, odd one small (244)
2. two squares, one triangle (444)
3. three triangles, odd one inverted (444)
4. three triangles, odd one red (444)
5. three triangles, odd one white (444)
6. three triangles, odd one upright (444)
7. two triangles, one square (444)
8. three triangles, odd one large (224)

[6]The numbers in parentheses denote the lengths in inches of the sides of the squares or the equilateral triangles used as stimulus objects in a given test.

The stimulus objects were planometric, plastic, and white (except in tests 4 and 5), and were presented horizontally on a wooden tray, 9½ in. by 26 in., painted flat black, with three shallow holes bored equidistantly along a line running lengthwise down the center of the tray to contain the candy reward. A movable screen concealed the arrangement of the stimulus objects and the baiting of the correct choice for each trial from the subject. Position of the correct choice was varied from trial to trial. Red hots and social approval of the experimenter were used as the reinforcer.

Each S was brought to the testing room by E and seated at a table on which only the presentation tray appeared. Another adult, who acted as recorder, sat to the rear and side of E. The stimulus materials, red hots, and paper cups (to serve as containers for the candy won by the child) were on a chair or low table beside E and out of sight of S.

S was then told: "Here's a board with holes in it and here's a candy. We're going to play a game where I put the candy in one of these holes and cover it with one of these cards. When you find the candy, you may keep it. I'll put the candy here this time and cover it with this card." (E then covered remaining holes.) "Now I'll hide it and when I take the screen away you can find it." (E placed and then removed screen.) If S chose correct stimulus, he was given candy and a paper cup to contain it. If S chose one of the two incorrect objects, E moved the correct object, revealing the candy, and told S, "It is under this card, isn't it?" (E pointed to correct stimulus.) "Let's try it again." Procedure was repeated until S chose correct stimulus object on demonstration trial. Upon completion of demonstration, E began training series by putting

screen in place and hiding candy. During training, the following statement was made after every trial: "It is always under this card (E points) in this game."

After criterion of four successive correct responses was reached on the first training series, the second training series was introduced without comment or demonstration. After the first trial, S was told: "This is a new game and candy will always be under this card (E points) in this game." Upon attainment of criterion in this series, six noncorrected trials were given without introduction on each of the eight tests in the order already stated.

Learning-of-Middle-Size Task (LMST)

The task was choosing from a set of three objects the one intermediate in size. The stimulus objects were wooden cubes, painted white, and presented on the black tray already described. The training series, run with correction to criterion of five successive correct responses, utilized cubes with edges 3, 4, and 5 in., respectively. There followed, in random order, two tests, each with six noncorrected trials: one, with 2, 3, and 4 in. cubes; two, with 4, 5, and 6 in. cubes. The physical arrangements, procedure, and reinforcement were, in all other respects, virtually identical with those in the CLT.

S was told: "Here's a board with holes in it and here's a candy. We're going to play a game where I put the candy in one of these holes and cover it with one of these blocks. When you find the candy, you may keep it. I'll put the candy here this time and cover it with this block." (E then covered remaining holes.) "Now I'll hide it and when I take the screen away you can find it." (E placed and then removed screen.) If child chose correct stimulus, he was given candy and a paper cup as container.

If he made an incorrect choice, E moved the correct object, revealing the candy, and said, "It is under this block, isn't it? (E pointed to correct object.) Let's try it again." Procedure was repeated until S chose correct stimulus object on demonstration trial. Upon completion of demonstration, E began training series by putting screen in place and hiding candy. During training, when S made an incorrect response, he was shown the correct stimulus object. After criterion of five successive correct responses was reached on training, six noncorrected trials on each of the two tests were given without introduction or demonstration.

Analysis of Data[7]

As intended and as expected from experience with preliminary testing, all subjects completed the training series on both the OLT and the LMST with little difficulty. Treatment of the data was therefore confined to scores on the test series on the two tasks. Utilizing different groups of subjects, tasks, and scores, three analyses of these data have been completed. They concern: (a) transposition of the concept of oddity in normal children as a function of chronologic age and nature of stimulus cue; (b) transposition and learning of the concept of oddity in normal and mentally subnormal children; (c) transposition and learning of the concept of middle size in normal and mentally subnormal children. The subjects and data used, the method of analysis applied, and the results obtained in each case will be described in detail in the following sections.

[7]The investigators wish to express their great appreciation for the advice and assistance of James Norton, Purdue Statistical Laboratory, in the statistical analysis of the data.

Age Changes in Effects of Irrelevant Cues on Discrimination Learning in Normal Children[8]

Previous developmental studies of transposition in normal children have utilized a single unidimensional test, that is, involving but one discriminandum, most commonly size or form. The oddity learning task (OLT) utilized in this study, in contrast, was a version of the multiple-sign problem (Harlow, 1951) in that there was ambiguous reward of more than one cue within the test series. It can also be viewed as involving irrelevant cues (Lawrence, 1949, 1950), cues which are sometimes rewarded, sometimes not. Within any one test, the discrimination was a relatively simple one. But, over the sequence of eight tests, the child was confronted with a number of irrelevant cues: that is, no one discriminandum was consistently rewarded, although the underlying basis of discrimination--oddity--remained constant throughout the series. Moreover, in the two tests utilizing size as the cue, for example, the correct choice was at one time the smaller, at another time, the larger; similarly, in the two tests with form as the cue, the correct choice was the triangle in the first test, the square in the second test; etc.

The purpose of the first analysis of data was to determine age changes in transposition (as measured by response on trial 1 of each of the tests) of the concept of oddity, necessarily involving irrelevant cues, in normal children. The subjects included 141 normal, middle-class children, 80 boys, 61 girls, subdivided by year-of-age into eight

[8]Paper read at Midwest. Psychol. Ass., Chicago, May, 1959. An elaborated version is being submitted for publication.

groups from 3 through 10 years.[9] Table 1 contains the description of these subjects. (Mental ages were available for only a portion of the group and are therefore not reported.)

Table 1

Description of Normal Subjects Utilized in Developmental Analysis of OLT Transposition Data

Year-of-Age	N			Chronologic Age Means		
	Boys	Girls	Total	Boys	Girls	Total
3	4	5	9	41.0	44.0	42.7
4	16	7	23	53.4	53.0	53.3
5	9	5	14	65.0	63.6	64.5
6	6	8	14	76.0	76.8	76.4
7	13	11	24	91.6	91.7	91.7
8	13	7	20	100.5	97.9	99.6
9	9	12	21	116.8	115.6	116.1
10	10	6	16	123.3	121.7	122.7
Younger (3-6)	35	25	60	58.9	60.9	59.7
Older (7-10)	45	36	81	106.3	105.9	106.1
All (3-10)	80	61	141	85.5	87.4	86.5

[9]Only two normal, middle-class children of the total number tested exceeded these age limits, both girls, one 35 months old, one 134 months old, when OLT was administered.

The mean number of correct responses on trial 1 for all tests at each age level for boys, girls, and the total group are given in Table 2. The lowest age mean was 2.7 at age 3, the highest, 7.1 at age 10, out of a possible 8 in each case.

Table 2

Mean Number of Correct Responses on Trial 1 of OLT for All Tests for Subgroups of Normal Subjects at Each Age Level

Year-of-Age	3	4	5	6	7	8	9	10
Boys	2.8	3.1	3.9	5.3	6.5	6.9	6.0	7.5
Girls	2.6	2.9	4.2	3.9	5.0	6.6	5.9	6.5
Both	2.7	3.0	4.0	4.5	5.8	6.8	6.0	7.1

The summary of the analysis of variance of these data, with a correction for disproportionate Ns within the cells (Snedecor, 1946), is presented in Table 3. The age differences are significant at the .01 level, the sex difference, significant at the .05 level; the sex-age interaction is not significant. Using one-tailed t tests, the following differences between adjacent age levels can be shown to be significant: 4 and 5, 6 and 7, 7 and 8, and 9 and 10. The last must be held suspect in view of the inexplicable drop between 8 and 9, particularly since the difference between 8 and 10 is not significant. By computing successive F tests between chronologic age level means, dropping off successive levels, one at a time, from the youngest up (Table 4), it was found that levels differ significantly until the 3-, 4-, 5-, and 6-year-old groups have been dropped, whereupon the remaining age groups do not differ significantly from one another, considering that the difference between 8 and 10 has already been shown to be nonsignificant.

Table 3

Analysis of Variance of Correct Responses on Trial 1 of OLT for Normal Subjects

Source	df	Mean Square	F
Sex (S)	1	12.78	5.01*
Age Levels (A)	7	46.57	18.23**
S x A	7	1.95	0.76
Individual (error)	125	2.55	

*Significant at less than .05 level.
**Significant at less than .01 level.

Table 4

Successive F Tests between Mean Number of Correct Responses on Trial 1 of OLT for Normal Subjects at the Various Age Levels

Age Levels	df	Mean Square	F MS/2.55
3 - 10	7	46.57	18.23**
4 - 10	6	44.88	17.57**
5 - 10	5	22.68	8.88**
6 - 10	4	13.51	5.29**
7 - 10	3	6.30	2.47
8 - 10	2	5.68	2.22
9 - 10	1	10.20	3.99*

*Significant at less than .05 level.
**Significant at less than .01 level.

These normal subjects were then divided into two subgroups: younger, aged 3 through 6 years, and older, 7 through 10 years. By combining tests 1 and 8 involving size, tests 2 and 7 involving form, tests 3 and 6 involving spatial orientation, and tests 4 and 5 involving color, it was possible to examine the results according to the nature of the test, eliminating the effects of the sequence in which the tests were given.

Table 5 shows the mean number of correct responses on trial 1 for each type of test for each subgroup, further subdivided by sex. The order from most to least difficult was the same in all groups: orientation, size, color, form. But the differences within groups, while consistent in trend among tests, were slight except in the case of the younger boys.

Table 5

Mean Number of Correct Responses on Trial 1 of OLT by Age, Sex, and Type of Test for Normal Subjects

Tests	3 + 6	1 + 8	4 + 5	2 + 7
Type	Orientation	Size	Color	Form
Younger				
Boys	.6	.6	1.1	1.4
Girls	.7	.8	.9	.9
Both	.6	.7	1.0	1.2
Older				
Boys	1.6	1.7	1.7	1.7
Girls	1.4	1.4	1.5	1.6
Both	1.5	1.6	1.6	1.7

An analysis of variance of these data, summarized in Table 6, indicates that the over-all interaction between age-sex groups and type of test is significant at the .01 level. This may be taken to mean that the pattern across the four kinds of test is different for the several groups. Additional tests were made to compare the patterns of selected pairs of age-sex groups. The younger males differ significantly from the younger females and also from the older males at the .01 level; the younger females do not differ significantly from the older females; nor do the older males differ from the older females in pattern of response across the four types of test.

Table 6

Analysis of Variance: Interaction between Age-Sex Groups and Type of Test in OLT for Normal Subjects

Source	df	Mean Square	F
Groups x Tests			
Over-all	9	.87	3.32**
Younger: Boys vs. Girls	3	1.37	5.23**
Older: Boys vs. Girls	3	.05	.21
Boys: Younger vs. Older	3	2.18	8.35**
Girls: Younger Vs. Older	3	.03	.11
Subjects x Tests (error)	411	.26	

**Significant at less than .01 level.

Transposition and Oddity Learning in Normal and Retarded Children[9]

The purpose of the second analysis of data was to make a comparative study of transposition and learning in normal children and in two types of mentally subnormal children, familial and mongoloid. The measure of transposition used was the number of correct responses on trial 1 of the eight tests in the oddity learning task (OLT); the number of correct responses on trials 2-6 of the eight tests in the same task provided the measure of learning, following Harlow (1949).

The mentally subnormal subjects included all familials (24 boys and 20 girls) and all mongoloids (12 boys and 10 girls) in the two state institutions for whom complete test records were obtained. Intelligence data on all these subjects were available, either from the Stanford-Binet or the Wechsler Intelligence Scale for Children. From these IQs were estimated mental ages as of the time of the administration of the OLT. Mental ages for as many of the normal children as possible were similarly estimated, again using only scores on the two individual tests. After arbitrarily eliminating all normal children whose MA exceeded 124 (corresponding roughly to the upper limit of the MA range for the retardates), there remained 30 boys and 30 girls of normal intelligence, that is, with IQs of 88 or above. For purposes of the analysis, it was necessary to reduce the number of girls to 25 so that the sex ratio would be the same in all three groups of children. The 30 girls were thus arranged in order from lowest to highest in MA and every fifth subject eliminated. (With the exception of two girls and one boy, all normal subjects were classified as middle class.) Table 7 contains the description of the three groups of subjects.

[9]An extended version of this section is being submitted for publication.

Table 7

Description of Subjects Utilized in Comparative Analysis of OLT Data

		CA			MA			IQ		
	N	M	SD	Range	M	SD	Range	M	SD	Range
Normal										
Boys	30	67.9	18.7	36/100	78.3	24.4	46/124	114.8	12.3	92/140
Girls	25	74.3	27.6	35/134	84.6	27.3	40/124	116.1	13.7	88/139
Both	55	70.8	23.2	35/134	81.2	25.7	40/124	115.4	12.7	88/140
Familial										
Boys	24	167.2	18.4	124/192	84.5	16.9	48/123	51.8	8.6	38/ 68
Girls	20	155.8	19.7	119/191	80.0	15.4	57/113	52.2	8.5	40/ 71
Both	44	162.0	19.7	119/192	82.4	16.0	48/123	51.9	8.5	38/ 71
Mongoloid										
Boys	12	152.8	31.1	109/200	47.0	12.9	31/ 72	31.6	6.1	22/ 42
Girls	10	144.7	41.2	95/205	40.5	11.6	12/ 54	29.6	8.8	11/ 43
Both	22	149.1	35.4	95/205	44.0	12.5	12/ 72	30.7	7.3	11/ 43

Transposition

The mean number of correct responses on trial 1 for all tests for the three groups of subjects and by sex within groups are given in Table 8. An analysis of variance of these data shows the group differences to be significant but not the sex differences nor the interaction between groups and sex. The summary of the analysis of covariance, presented in Table 9, provides tests of significance based on means adjusted for differences between the groups in MA. Group differences are not now significant, but the sex difference is, as is the group x sex interaction.

Table 8

Mean Number of Correct Responses on Trial 1 of OLT for Normal, Familial, and Mongoloid Subjects

	Normal	Familial	Mongoloid
Boys	4.6	5.0	2.3
Girls	3.7	4.2	3.1
Both	4.2	4.6	2.7

Table 9

Analysis of Covariance of Correct Responses on Trial 1 of OLT for Normal, Familial, and Mongoloid Subjects

Source	df	Mean Square	F
Groups (G)	2	1.65	.74
Sex (S)	1	10.96	4.96*
G x S	2	9.89	4.47*
Within cells (error)	114	2.21	

*Significant at less than .05 level.

The adjusted means of correct responses on trial 1 appear in Table 10. In both the normal and familial groups the boys performed better than the girls; in the mongoloid group the girls were superior. Only the

difference between normal boys and girls is significant (t = 2.98, df = 114, $p < .01$).

Table 10

Adjusted Mean Number of Correct Responses on Trial 1 of OLT for Normal, Familial, and Mongoloid Subjects

	Normal	Familial	Mongoloid
Boys	4.5	4.6	3.5
Girls	3.3	3.9	4.6
Both	3.9	4.3	4.0

Table 11 presents the mean number of correct responses on trial 1 of OLT for each sex within each group and for the total groups according to type of test. There was no clear-cut pattern of difficulty as was found in the developmental analysis of the data on the larger group of normal subjects, perhaps because the extended age range served to obscure any trend within sexes. However, in both normal and familial subjects in the comparative analysis the orientation tests again tended to be most difficult, the form tests, the least difficult. The performance of the mongoloid boys did not depart markedly from this pattern; that of the mongoloid girls was quite different, almost a reversal, with form the most difficult, color, the least difficult. A summary of an analysis of variance of these data, presented in Table 12, serves to assess differences in pattern of performance between groups without regard to level of performance.

Table 11

Mean Number of Correct Responses on Trial 1 of OLT by Sex and Type of Test for Normal, Familial, and Mongoloid Subjects

Tests	3 + 6	1 + 8	4 + 5	2 + 7
Type	Orientation	Size	Color	Form
Normal				
Boys	1.0	.9	1.2	1.6
Girls	.7	.8	1.0	1.1
Both	.8	.9	1.1	1.4
Familial				
Boys	.9	1.4	1.3	1.4
Girls	.8	1.0	1.0	1.4
Both	.9	1.2	1.1	1.4
Mongoloid				
Boys	.5	.4	.7	.8
Girls	.8	.7	1.3	.3
Both	.6	.5	1.0	.5

Table 12

Analysis of Variance of Correct Responses on Trial 1 of OLT by Type of Test for Normal, Familial, and Mongoloid Subjects

Source	df	Mean Square	F
Tests (T)	3	4.05	12.82**
T x Groups (G)	6	1.20	3.79**
T x Sex (S)	3	.34	1.08
T x G x S	6	.72	2.27*
T x Subjects (error)	345	.32	

*Significant at less than .05 level.
**Significant at less than .01 level.

The tests differ significantly in difficulty; the pattern of difficulty varies significantly between groups but not between sexes; the pattern of difficulty between sexes varies significantly from group to group. An inspection of the means in Table 11 indicates that the mongoloid group--the mongoloid girls, particularly--accounts for the significant interactions.

Learning

Table 13 presents the mean number of correct responses on trials 2-6 for all tests for the three groups of subjects and by sex within groups. According to an analysis of variance of these data, the differences between groups are significant; those between sexes are not; nor is the interaction between groups and sex. As before, an analysis of covariance, summarized in Table 14, was used to test for significance of differences after adjustment of means for group differences in MA. Group differences remain significant.

Table 13

Mean Number of Correct Responses on Trials 2-6 of CLT for Normal, Familial, and Mongoloid Subjects

	Normal	Familial	Mongoloid
Boys	29.8	30.3	17.2
Girls	30.0	26.6	19.1
Both	29.9	28.6	18.0

Table 14

Analysis of Covariance of Correct Responses on Trials 2-6 of OLT for Normal, Familial, and Mongoloid Subjects

Source	df	Mean Square	F
Groups (G)	2	170.11	5.10**
Sex (S)	1	23.76	.71
G x S	2	63.35	1.90
Within cells (error)	114	33.38	

**Significant at less than .01 level.

The adjusted means of correct responses on trials 2-6 are given in Table 15. The performances of the normal and familial subjects do not differ significantly. But the familials and the mongoloids differ significantly ($t = 2.78$, $df = 114$, $p < .01$), as do the normals and the mongoloids ($t = 3.84$, $df = 114$, $p < .01$).

Table 15

Adjusted Mean Number of Correct Responses on Trials 2-6 of OLT for Normal, Familial, and Mongoloid Subjects

	Normal	Familial	Mongoloid
Boys	29.2	28.7	21.9
Girls	28.3	25.8	24.9
Both	28.8	27.4	23.2

The mean number of correct responses on trials 2-6 of OLT for each sex within each group and for the total groups according to type of test are given in Table 16. The order from most to least difficult was the same for both sexes in both the normal and familial group: orientation, color, size, and form. (One exception may be found in the familial girls where the size and form tests were equally difficult.) No such consistent pattern characterized the mongoloid boys and girls and total group; but the orientation tests were most difficult, and the size tests tended to rank second in difficulty.

Table 16

Mean Number of Correct Responses on Trials 2-6 of OLT by Sex and Type of Test for Normal, Familial, and Mongoloid Subjects

Tests	3 + 6	1 + 8	4 + 5	2 + 7
Type	Orientation	Size	Color	Form
Normal				
Boys	5.4	8.4	7.1	8.8
Girls	5.2	8.6	7.4	8.8
Both	5.3	8.5	7.3	8.8
Familial				
Boys	5.6	8.2	8.1	8.3
Girls	5.0	7.4	6.7	7.4
Both	5.4	7.9	7.5	7.9
Mongoloid				
Boys	2.8	4.4	4.8	5.1
Girls	3.4	4.6	6.5	4.6
Both	3.1	4.5	5.6	4.9

A test of the significance of differences in pattern of performance on the several types of test, without regard to level of performance, is provided by an analysis of variance of these data, presented in Table 17. The tests do differ significantly in difficulty, and the relative difficulty varies with group. Again, it must be presumed that the mongoloid group accounts for these significant differences.

Table 17

Analysis of Variance of Correct Responses on Trials 2-6 of OLT by Type of Test for Normal, Familial, and Mongoloid Subjects

Source	df	Mean Square	F
Tests (T)	3	204.11	87.89**
T x Group (G)	6	11.72	5.05**
T x Sex (S)	3	.74	.32
T x G x S	6	2.95	1.27
T x Subjects (error)	345	2.32	

**Significant at less than .01 level.

Transposition and Learning of Concept of Middle Size in Normal and Retarded Children

The learning-of-middle-size task (LMST) was administered to all children (with the exception of one girl) in the familial group at one state institution: a total of 28 subjects, 17 boys and 11 girls. Their mean CA was 174.0 months with a SD of 17.7 and a range of 138-199. In

MA the mean was 88.1 months, the SD, 16.4, and the range, 65-123. The mean IQ of the group was 52.7, the SD, 9.3, and the range, 38-71.

A group of 24 children, 16 boys and nine girls, from the city community center was also given this task. Their mean CA was 76.0 months with a SD of 19.5 and a range of 46-116. No intelligence data on these subjects were available; however, on the plausible assumption that they were of at least average ability, their mean MA should be equal to or greater than that of the familial group. Of these children, eight of the boys and five of the girls were classified as working class.

Thirteen, or 52 per cent, of the normal subjects transposed on neither of the two test trials; nor did 18, or 64 per cent, of the familial subjects. A chi square test of the difference in incidence of transposition is not significant.

On trials 2-6 of both test series combined, the mean number of correct responses (of a possible 10) for the normal group was 7.6, for the familial group, 7.2. A *t* test shows this group difference to be nonsignificant.

Discussion

The results may be reviewed in two ways: first, with respect to the questions posed by the present investigation (see page 4); second, with respect to findings of other recent studies of discrimination and generalization in mentally normal and subnormal children.

Measurement of Discrimination Learning and Generalization

The problem designed particularly for this investigation, the Oddity Learning Task (OLT), proved highly satisfactory for the comparative analysis of the performance of mentally normal and subnormal subjects in that: (a) it required only 15 or 20 minutes for administration; (b) it was not too easy, nor was it too difficult, for subjects ranging in chronologic age from 35 to 205 months, in mental age from 12 to 130 months, and in IQ from 11 to 140; (c) it served to differentiate among subjects by chronologic age, by sex, by mental age, and by etiologic classification of mental subnormality; (d) it provided measures of both transposition and learning; (e) it permitted a determination of variation in performance with changes in the nature of the discriminandum. The Learning-of-Middle-Size Task (LMST), as expected, proved to be a much less sensitive test.

Relation of Performance to CA and MA

The size and composition of the two groups of mentally handicapped children were such that it was not possible to make a systematic developmental analysis of their performance with relation to chronologic and mental ages. There was no relation in the mongoloid group between total number of correct responses (transposition and learning) on the OLT and MA, CA, or IQ for either boys or girls. For the familials, there was a rank-difference correlation of .55 between total score and both MA and IQ, significant at

the .02 level, for girls. In the group of normal children used for the comparative analysis of the OLT data, the correlation between total score and MA was .63 for boys and .79 for girls (both significant at the .01 level); between total score and CA, the respective coefficients were .62 and .80, again both significant at the .01 level. There was no relation between performance and IQ. In view of the large variance in both MA and CA for all groups of subjects (see Table 7), these correlations must be viewed with considerable reservation. There was no relation between total score on the LMST and CA for normal subjects or between that score and MA, CA, or IQ for the familial subjects on the same task. A developmental analysis of transposition in normal subjects on the OLT did find an earlier cessation of improvement with CA than heretofore noted.

Group Differences in Performance

With regard to transposition, as measured by number of correct responses on trial 1 for all tests, there were no significant differences between normal, familial, and mongoloid subjects on the OLT after adjustment of means for differences in MA. Before adjustment, there was a significant difference associated with groups which, in view of the fact that the normals and familials were comparable in mean MA, must be attributed to the performance of the mongoloids. Nor was there a significant difference in transposition behavior between normal and familial subjects, also presumably comparable in average MA, who were tested on the LMST. There were significant sex differences among the groups and a significant interaction between sex and groups on the OLT: in both the normal and familial groups the boys tended to perform better than the girls; the reverse was true in the mongoloid group. Only the sex difference for the normal subjects was

significant.

When the data on transposition behavior in the OLT were analyzed by type of stimulus cue, significant differences in difficulty among tests were found with the pattern of difficulty varying significantly with group but not with sex; however, the differences in pattern of difficulty between sexes did vary between groups. For both the normal and familial subjects, orientation was the most difficult discriminandum, form, the least difficult. This finding is identical with that for the normal subjects in the developmental analysis; in that analysis, moreover, the sex difference in difficulty was much more marked in the boys than in the girls at the 3- through 6-year-old CA range. Among the mongoloids as a whole the pattern was quite different; the form and size tests were the most difficult and the color tests, the least difficult. But the order of difficulty differed by sex within the group. In view of the fact that the means in some cases did not equal chance scores (.67), the reliability of the pattern data for the mongoloids is somewhat questionable.

An analysis of the learning data (trials 2-6) on all tests showed significant differences among groups before and after adjustment for differences in MA. The familials and normals were both superior to the mongoloids; they were not significantly different from each other. Nor did the familials and normals differ with respect to learning on the LMST. According to an analysis of the OLT data by type of test, there was again a significant difference in difficulty between tests and in pattern of difficulty between groups. As before, the order of difficulty from least to most was the same for both normal and familial subjects: form, size, color, orientation. A similar pattern also characterized the mongoloid

boys, but the mongoloid girls again experienced difficulty in discriminating form. Since the mean scores for learning generally exceeded chance expectancy, some confidence can be placed in this finding.

Etiology of Mental Subnormality and Performance

Mentally normal children and familial-type mentally subnormal children of comparable mental age did not differ in discrimination learning or in transposition on either of the two tasks. Nor did the pattern of difficulty associated with the several types of discriminanda differ for these two groups. Within both groups, boys tended to perform at a higher level than did girls.

The performance of the mongoloids, in contrast, was quite inferior quantitatively and dissimilar qualitatively. These subjects were inferior on all measures, except total score on transposition on the OLT, even after statistical adjustment for their inferior mental ability. In contrast to findings for the other groups, girls tended to perform better than boys. Their pattern of differential sensitivity to discriminable properties of the test stimuli differed from that which characterized the normal and familial subjects. Furthermore, boys and girls within this group did not exhibit the same pattern of performance.

Relation of Findings of This and Other Studies

To compare the findings of the present study with those of other recent investigations of learning in mentally normal and subnormal children and to generalize the results pose some difficulties:

a. The nature of the learning task varies from study to study. Some research has involved the discrimination of a large number of pairs of objects differing multidimensionally and the formation of learning sets

(House and Zeaman, 1958b, 1958c; Kaufman and Peterson, 1958; Stevenson and Swartz, 1958). Others have used unidimensional discrimination problems of color (Koch and Meyer, 1959), form (Ellis, 1958; Ellis and Sloan, 1959; Girardeau, 1959), size (Stevenson and Iscoe, 1955); position with reversals (House and Zeaman, 1958a); and size with reversals (O'Connor and Hermelin, 1959); some with intertrial or interproblem elaborations. House and Zeaman (1958a) utilized a bidimensional (color and form) discrimination task. The significance of this diversity in experimental problem is underlined by the fact that in the present study there was no relation between over-all performance in either the normal or familial groups who were administered two different tasks.

b. In some studies the same task is given to both normal and subnormal subjects (Ellis, 1958; Ellis and Sloan, 1959; Girardeau, 1959; House and Zeaman, 1958a; Kaufman and Peterson, 1958; O'Connor and Hermelin, 1959; Stevenson and Swartz, 1958). In the remaining research cited, only one group of subjects, normal or subnormal, is studied. In the comparative studies, a task limit for the normal subjects is sometimes present.

c. The composition of the subnormal group, with respect to diagnostic classification, varies from study to study. Girardeau (1959) restricted his retarded group to mongoloids; Stevenson and Swartz (1958) included only familials. Some investigators have excluded certain categories: epileptics; severely crippled and/or handicapped, sensory or neurological; clinical types such as mongoloids (Ellis, 1958; Ellis and Sloan, 1959); Kaufman and Peterson, 1958). Others have used completely undifferentiated groups.

d. In no investigation, including the present one, has sampling, in

any sense of that word, been possible. The population or populations to which research findings are applicable can therefore not be determined.

With these difficulties in mind, the findings of the present study will be compared with those of other similar investigations. There is agreement that mentally subnormal subjects perform at an inferior level on a variety of discrimination learning tasks. However, the data from most studies suggest, at least by implication, that comparability of performance is associated with comparability of mental age, as was the case with the normals and familials, but not the mongoloids, in the present study. On the other hand, House and Zeaman (1958a) found a significant difference between undifferentiated retarded subjects and normals of the same mental age on a color-form discrimination. Similarly, Girardeau (1959), in agreement with the study reported here, reported that his normal and mongoloid subjects of comparable mental age differed significantly on a form discrimination task with interproblem variation in size, color, and form. The imbeciles in the O'Connor and Hermelin (1959) study showed greater facility than the normals on the reversal task.

Ellis and Sloan (1959) reported significant correlations between performance and MA and IQ (.48 and .55, respectively), but not CA, for their retarded subjects; as will be recalled, the present investigators found a similar relationship ($r = .55$) for both MA and IQ with OLT performance, but only for familial girls; in the normal group high correlations for both boys and girls existed between scores on the same task and both MA and CA, but not IQ. Koch and Meyer (1959) reported a correlation of .59 between learning scores and mental age for their normal children.

There is also general agreement that learning varies with the type

and complexity of the discrimination. The normal subjects in the present study showed an age progression in transposition like that found in earlier studies. However, improvement ceased at an earlier level than previously reported for somewhat simpler tasks. Furthermore, performance in both normal and subnormal subjects varied with the nature of the discriminandum. Other research findings are not incompatible with these. For example, House and Zeaman (1958b, 1958c) were unable to obtain a learning set in their undifferentiated retardates using a multidimensional discrimination, but they were able to do so on a position discrimination with reversals (1959).

Sex differences, such as those reported here, have not been identified or have not appeared in other investigations. These differences in overall performance and in sensitivity to discriminanda seem to be related to age, at least among normals, and to diagnostic classification among the mentally subnormal. The data provide no explanations for these findings, but one is tempted to speculate that there are sex differences in cultural influences on cognitive development that cause normal boys particularly, to be less responsive to stimulus properties of size and spatial orientation than to those of color and form.

Whether the familial type of mentally subnormal child suffers a learning deficit that cannot be fully explained by his lower mental age must, in view of available knowledge, remain a question. But it seems safe to say that some types of mentally retarded children are characterized by a learning, as well as by a mental age, deficit. Zeaman (1959) has suggested as a likely source of such a deficit the inability of such children "to direct and maintain their attention to the relevant dimensions of the problem stimuli (those correlated with reward)" (p. 63). The findings

of the present study, particularly those concerning variation in performance with the discriminandum, give support to this suggestion. So do the observations of Girardeau (1959) and Stevenson and Swartz (1958) that their subjects were more distractible and less task-oriented and made more irrelevant remarks. The finding of Kaufman and Peterson (1958) that their retardates made more stimulus-perseveration errors is also relevant. The difference in the performance of the two groups of subnormal subjects in the present study reinforces the need, as expressed by Benson and Gladwin (1958), for distinguishing between mental deficiency and mental retardation.

Implications for Further Research

On the basis of a consideration of the findings of the present study and other relevant investigations, the following suggestions for research on learning in mentally subnormal children seem warranted:

1. There is a need for a standard series of discrimination learning tasks with systematic variation in both the complexity of the discrimination and the stimulus properties to be differentiated, both within and between trials or problems. At some point, some multiple other than the visual should be utilized.

2. Mentally retarded subjects should be more carefully selected and described with respect to diagnostic classification.

3. In view of the difficulty of obtaining mentally retarded subjects of unequivocal classification and within desired chronologic and mental age ranges, it would seem desirable to have some form of area-wide or even nation-wide cooperation among research workers in this area.

Summary and Conclusions

The present study undertook a comparative-developmental analysis of transposition and learning in young mentally normal and mentally subnormal children in an attempt to determine the extent and nature of the learning deficit, if any, of the mentally retarded child.

Two tasks were devised: (1) The Oddity Learning Task (OLT); (2) The Learning-of-Middle-Size Task (LMST). The first involved choosing the odd one of three stimulus objects, with oddity defined in terms of either size, color, form, or spatial orientation. There were two training series, each run with correction to criterion of four consecutive correct responses: (1) three squares, odd one small; (2) three squares, odd one large. There were then eight tests, each with six noncorrected trials, introduced without comment to all subjects in the following sequence: (1) three triangles, odd one small; (2) two squares, one triangle; (3) three triangles, odd one inverted; (4) three triangles, odd one red; (5) three triangles, odd one white; (6) three triangles, odd one upright; (7) two triangles, one square; (8) three triangles, odd one large. Four scores were obtained on each subject for this task: (1) transposition, number of correct responses on trial 1 for all tests; (2) transposition, number of correct responses on trial 1 for each type of test (color, form, size, and orientation); (3) learning, number of correct responses on trials 2-6 for all tests; (4) learning, number of correct responses on trials 2-6 by type of test.

In the second task (LMST) the subject had to choose from a set of three objects the one intermediate in size. The stimulus objects were wooden cubes, painted white, and in six sizes. The training series, run with correction to criterion of five successive correct responses, utilized cubes

with edges, 3, 4, and 5 in. respectively. There followed, in random order, two tests, each with six noncorrected trials: one, with 2, 3, and 4 in. cubes; two, with 4, 5, and 6 in. cubes. From this task there was obtained a transposition score (number of correct responses on trial 1 for both tests) and a learning score (number of correct responses on trials 2-6 for both tests).

Two groups of mentally subnormal children were obtained: 44 diagnosed as familial, 24 boys and 20 girls; 22 diagnosed as mongoloid, 12 boys and 10 girls. For the combined groups the CA range was from 95 to 205 months; the IQ range, 11 to 71. Mentally normal children were obtained from nursery schools, elementary schools, and community centers. The group included a total of 174, 96 boys and 78 girls, with a CA range of 30 to 134 months and an IQ range of 88 to 140, the latter for subjects for whom intelligence data were available.

All children, normal and subnormal, were administered the OLT. Subgroups of the normal and the familial subjects were also given the LNST.

Three main analyses of the data were obtained: (a) a developmental analysis of transposition of the concept of oddity in normal children as a function of chronologic age and nature of stimulus cue; (b) a comparative analysis of transposition and learning of the concept of oddity in normal, familial, and mongoloid subjects; (c) a comparative analysis of transposition and learning of the concept of middle size in normal and familial children.

The major results may be summarized briefly as follows:

Developmental Analysis (OLT)

1. Transposition improved with age in normal children until about 8 years.

2. Performance of boys was superior to that of girls.

3. Performance varied significantly with type of test, especially in the younger boys, with this order of difficulty, from least to most: form, color, size, orientation.

Comparative Analysis (CLT)

1. A significant difference among normal, familial, and mongoloid groups in total transposition score disappeared after adjustment of the means for differences in mental age. There was a significant sex difference and a significant interaction between sex and groups: the boys were superior to the girls in both the normals and the familials; the reverse was true in the mongoloids; only the difference in the normal group was significant.

2. There was a significant difference in difficulty among tests; the pattern of difficulty varied significantly with group but not with sex; however, the difference in pattern of difficulty between sexes varied significantly with group. For both the normals and the familials, orientation was most difficult, form, least difficult. In the mongoloid group, the pattern was less clear, with sex differences and with the means for orientation, size, and form below or equal to chance expectancy.

3. For learning scores based on all tests, the groups differed significantly both before and after adjustment for differences in intelligence: the normals and familials were superior to the mongoloids, but they did not differ from each other.

4. According to the learning data, the tests differed significantly in difficulty as did the pattern of difficulty between groups. Again, the order of difficulty, from least to most, was the same for both the normal and familial groups: form, size, color, orientation. The corresponding

order for the mongoloids was: color, form, size, orientation, but, as before, there were differences between boys and girls. Unlike the previous results, however, the means were, for the most part, greater than chance.

Comparative Analysis (LMST)

1. There was no difference between the normal and familial subjects in incidence of transposition.

2. The scores on the learning trials did not significantly differentiate between the normal and familial subjects.

On the basis of these findings and those of other recent studies on transposition and learning in mentally normal and subnormal children, it was concluded that:

1. There is some doubt whether subnormal children of the familial type suffer any learning deficit that cannot be accounted for by their mental age.

2. Mongoloid children experience difficulty in discrimination and generalization to a degree that cannot be fully attributed to their low mental age.

3. Learning difficulty is specific, in amount and in kind, to diagnostic classification of mental subnormality.

4. All children, normal and subnormal, respond differentially to different types of stimulus cues or discriminanda. This differential responsivity lends support to such explanations of learning deficit as point to the "ability to direct and maintain attention to important features of the environment" (Zeaman, 1959) as critical for learning.

Finally, there was suggested for future research the need (a) to

devise a standard series of learning tasks which vary in complexity, discrininnnda, and sensory modality; (b) a more careful selection and description of mentally retarded subjects with respect to etiology; and (c) more cooperation among research workers in this area with the primary purpose of making possible the sampling of populations of subjects of given characteristics.

References

ALBERTS, ELIZABETH, & EHRENFREUND, D. 1951. Transposition in children as a function of age. J. exp. Psychol., 41, 30-38.

ELLIS, N. R. 1958. Object-quality discrimination learning-sets in mental defectives. J. comp. physiol. Psychol., 51, 79-81.

ELLIS, N. R., & SLOAN, W. 1959. Oddity learning as a function of mental age. J. comp. physiol. Psychol., 52, 228-230.

GIRARDEAU, F. L. 1959. The formation of discrimination learning sets in mongoloid and normal children. J. comp. physiol. Psychol., 52, 566-570.

HARLOW, H. F. 1949. The formation of learning sets. Psychol. Rev., 56, 51-65.

HARLOW, H. F. 1951. Primate learning. In C. P. Stone (Ed.), Comparative psychology. (3rd ed.) Prentice-Hall. Pp. 183-238.

HILGARD, E. R. 1956. Theories of learning. (2nd ed.) Appleton-Century-Crofts.

HOUSE, BETTY J., & ZEAMAN, D. 1958a. A comparison of discrimination learning in normally and mentally defective children. Child Develpm., 29, 411-416.

HOUSE, BETTY J., & ZEAMAN, D. 1958b. Reward and nonreward in the discrimination learning of imbeciles. J. comp. physiol. Psychol., 51, 614-618.

HOUSE, BETTY J., & ZEAMAN, D. 1960. Visual discrimination learning in imbeciles. Amer. J. ment. Def., 63, 447-452.

HOUSE, BETTY J., & ZEAMAN, D. 1959. Position discrimination and reversals in low-grade retardates. J. comp. physiol. Psychol., 52, 564-565.

KAUFMAN, M. E., & PETERSON, W. M. 1958. Acquisition of a learning set by normal and mentally retarded children. J. comp. physiol. Psychol., 51, 619-621.

KOCH, MARGARET B., & MEYER, D. R. 1959. A relationship of mental age to learning-set formation in the preschool child. J. comp. physiol. Psychol., 52, 387-389.

KÖHLER, W. 1925. The mentality of apes. New York: Harcourt, Brace.

KUENNE, MARGARET R. 1946. Experimental investigation of the relation of language to transposition behavior in young children. J. exp. Psychol., 36, 471-490.

LAWRENCE, D. H. 1949. Acquired distinctiveness of cues: I. Transfer between discriminations on the basis of familiarity with the stimulus. J. exp. Psychol., 39, 770-784.

LAWRENCE, D. H. 1950. Acquired distinctiveness of cues: II. Selective association in a constant stimulus situation. J. exp. Psychol., 40, 175-188.

MILLER, N. E. 1934. The perception of children: a genetic study employing the critical choice delayed reaction. J. genet. Psychol., 44, 321-329.

O'CONNER, N., & HERMELIN, B. 1959. Discrimination and reversal learning in imbeciles. J. abnorm. soc. Psychol., 59, 409-413.

ODERKIRK, LILA J. 1959. Transposition in young children as a function of abstractness-concreteness of stimuli. Unpublished master's thesis, Purdue Univer.

SARASON, S. B., & GLADWIN, T. 1958. Psychological and cultural problems in mental subnormality: a review of research. Genet. Psychol. Monogr., 57, 3-290.

SNEDECOR, G. W. 1946. Statistical methods. (4th ed.) Ames, Iowa: State College Press.

SPENCE, K. W. 1937. The differential response in animals to stimuli varying within a single dimension. Psychol. Rev., 44, 430-444.

SPENCE, K. W. 1942. The basis of solution by chimpanzees of the intermediate size problem. J. exp. Psychol., 31, 257-271.

SPENCE, K. W. 1952. [illegible] Psychol. Rev., 59, 89-93.

SPIKER, C. C. 1956a. The effects of number of reinforcements on the strength of a generalized instrumental response. Child Develpm., 27, 37-44.

SPIKER, C. C. 1956b. Effects of stimulus similarity on discrimination learning. J. exp. Psychol., 51, 393-395.

SPIKER, C. C. 1956c. Experiments with children on the hypotheses of acquired distinctiveness and equivalence of cues. Child Develpm., 27, 253-263.

SPIKER, C. C. 1956d. The stimulus generalization gradient as a function of the intensity of stimulus lights. Child Develpm., 27, 85-98.

SPIKER, C. C. 1959. Performance on a difficult discrimination following pretraining with distinctive stimuli. Child Develpm., 30, 513-521.

SPIKER, C. C., & TERRELL, G., Jr. 1955. Factors associated with transposition behavior of preschool children. J. genet. Psychol., 86, 143-158.

STEIGMAN, M. J., & STEVENSON, H. W. 1960. The effect of pretraining reinforcement schedules on children's learning. Child Develpm., in press.

STEVENSON, H. W., & BITTERMAN, M. E. 1955. The distance-effect in the transposition of intermediate size by children. Amer. J. Psychol., 68, 274-279.

STEVENSON, H. W., & ISCOE, I. 1954. Overtraining and transposition in children. J. exp. Psychol., 47, 251-255.

STEVENSON, H. W., & ISCOE, I. 1955. Transposition in the feeble-minded. J. exp. Psychol., 49, 11-15.

STEVENSON, H. W., ISCOE, I., & McCONNELL, C. 1955. A developmental study of transposition. J. exp. Psychol., 49, 278-280.

STEVENSON, H. W., & LANGFORD, T. 1957. Time as a variable in transposition by children. Child Develpm., 28, 365-370.

STEVENSON, H. W., & McBEE, G. 1958. The learning of object and pattern discriminations by children. J. comp. physiol. Psychol., 51, 752-754.

STEVENSON, H. W., & PIROJINOFF, L. A. 1958. Discrimination learning as a function of pretraining reinforcement schedules. J. exp. Psychol., 56, 41-44.

STEVENSON, H. W., & ZWEIBEL, J. D. 1958. Learning set in children as a function of intellectual level. J. comp. physiol. Psychol., 51, 755-757.

STEVENSON, H. W., WEIR, M. W., & ZIGLER, E. F. 1959. Discrimination learning in children as a function of motive-incentive conditions. Psychol. Rep., 5, 95-98.

WHITE, S. H., & SPIKER, C. C. 1960. The effect of a variable conditioned stimulus upon the generalization of an instrumental response. Child Develpm., in press.

ZEAMAN, D. 1959. Discrimination learning in retardates. Training Sch. Bull., 56, 62-67.